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ABSTRACT

This paper identifies concerns and provides guidelines for the administrator or teacher who is involved in making decisions about acquiring, maintaining, or expanding computer resources. Several questions are raised and topics discussed which focus attention upon various specific elements in a system which are pertinent to procurement. Major questions are raised concerning meeting user needs, resource appropriateness, efficiency, equipment acquisition, and software procurement. A 28-item bibliography is attached. (Author/CMV)

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Number 14e

The Illinois Series on Educational Application of Computers

GETTING STARTED IN SCHOOL COMPUTING:

PREPARING TO PURCHASE

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To the reader,

This is one of a series of documents prepared as resources for the preservice and inservice training of teachers. The general theme of all items in this series is "teaching with or about computers". The booklets are the collective work of a variety of staff and students (both present and former) of the College of Education, University of Illinois at Urbana-Champaign. The project generously was supported between 1977 and 1979 by a grant from the EXXON Education Foundation. All resposibility for the content of these documents rests with the authors and does not reflect necessarily the views of the EXXON foundation. It was my extreme pleasure to direct this effort throughout.

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GETTING STARTED IN SCHOOL COMPUTING:

PREPARING TO PURCHASE

Use of computers for both administrative and instructional activities is becoming a reality. The marked increase in computer use prevalent outside of the educational field, coupled with the fact that the cost of computer equipment is declining while the number, variety, and capabilities of them are increasing, suggests that the upward trend in computer use in schools will continue. In order to integrate computer systems into various school functions, some means of determining which of the myriad of available computer systems, computer languages, or computer services best fit the needs of the individual institution.

In acquiring, maintaining, or expanding computer resources, school administrators, teachers, and consultants will be forced into making decisions regarding what product and/or services are needed for the school. They will, in effect, be formulating procurement policy. In so doing, they will need some basis for making their decisions, and some structure which can be used in identifying, outlining, and organizing the information requirements of their particular school environment.

It often is the case that procurement decisions must be made by resource personnel who are not familiar with computer technology. This paper is written for the administrator or teacher who will be involved in such decision making processes. Attempts are made at identifying the issues and concerns related to procurement decisions, and providing guidelines for addressing each of the identified concerns.

Initially, when desiring computer services, one is tempted to contact a dealer and say, "I want a computer". This has been done by school personnel with widely varying success. Certainly, for narrow applications or merely for exploration, such an approach might be appropriate as long as the price does not become too large. Of late, one frequently hears a school person say they just have purchased a micro-computer for their school attendance, or have puchased five micro-computers for a mathematics laboratory. The intended uses of such machines either are limited or not actually known. In effect, such purchases are for school research. Some times such strategies are appropriate in a particular context for limited applications.

On the other hand, more and more schools are facing the problem of acquiring major amounts of computer service to be used for broad and inclusive administrative or instructional tasks. In this case, multipurpose, shared resources may be considered on the "volume makes it cheaper per unit" theory. When such is the

procurement task, care must be exercised. Larger amounts of money will be at stake and the integrity of the resulting services probably will be very visible.

In the following pages, several questions are raised that must be answered before a decision to acquire any computer may be made. However, each of these questions is about the decision among several specific machines or services. In the discussion accompanying each question, we raise those matters to be decided or defined before investigating specific equipment. These matters are the ones to attend to while identifying your computer requirements. This discussion is general. The specific details of each set of requirements are derived by applying priciples of optimal computer use for that application. Such details come from other papers in this series. For example, ISEAC 15e and ISEAC 16e detail the task of defining administrative computing requirements, while ISEAC 11e describes the requirements of a system to be used for instructional management tasks (CMI). The questions raised and the topics discussed are intended to focus attention upon the various elements in a system which are pertinent to procurement. If careful attention is given to each topic area, then the resulting procurement should produce a system which possesses satisfactory characteristics.

How well does the system meet the needs of the user?

The following requirements relate to this question:

1. The needs of the community of users.
2. The composition of the intended user group.
3. The nature of the tasks to be accomplished.
4. The role the computer is to play in the school's future.
5. The direction the school is taking.
6. The long range plans of the school.

The needs of the user community should be one of the first problems addressed. Without an understanding of what the users of the system need, no basis for justifying decisions about what products or services to procure can be made. This may seem obvious, but many times people start trying to make decisions without doing this. The results usually are disasterous.

The composition of the intended user group is an equally important concern. It is necessary to determine the experience and abilities of those being served by the system. In particular, there is a need to look for attributes such as physical handicaps or poor reading or arithmetic skills which might later restrict the usefulness of some computer equipment or programming languages. Similarly, looking for existing competence in the intended audience which might be put to good use is important. For example, exceptional typing skills might indicate that programs should be entered using terminals or keypunches rather than mark sensed cards. Fluency in algebra might indicate that it would be beneficial to have a programming language such as APL. If some students are blind, then some sort of Braille printer or audio output device might be necessary. If music is to be taught, a method of producing musical sounds probably is in order (such as a "music box").

The nature of the task to be accomplished must be understood Also, reasons need to be sought to justify a computer system as the proper medium for accomplishing the task. Where such reasons cannot be found, there is a risk that user needs will not, in fact, be met by a computer system. Alternative media should be considered in such cases.

The role of the computer in the school's future often will affect the needs of the human part of the system. If the school is anxious to be at the forefront of technological progress in research, and to attain the state of the art in such fields, the needs of the system will be decidedly different from those of a school that primarily is interested in using previously developed techniques to supplement instruction or to improve their processing of information.

The direction a school is taking is closely related to the role which the computer is expected to play in the school's future. Acquisition of a computer system can change a direction by expanding or contracting a research program, or by increasing or decreasing the activity levels in subjects such as science, mathematics, and management. What this means is that a computer system can be used not only to enhance existing school functions, but also, to adjust the emphasis on such functions, or even to redirect where emphasis is placed.

Understanding the institution's long range plans involves identifying the current needs of the users, and projecting how those needs are likely to change within five or ten years. This is important for later decisions involving the kind and amount of computer equipment and services to seek and the manner in which those products should be procurred.

These last two considerations may be very difficult to determine. The large majority of high schools (and many junior colleges) simply do not plan this far into the future. Planning often goes no further than the next year's budget. If these considerations can be included, the outcome of such planning will be very beneficial.

How well does the computer respond to the demands of the user?

In order for a system to be considered responsive to the demands of its users, it must be able to answer questions dealing with:

1. The number of users.
2. The dispersion of the users.
3. The envisioned computer uses.
4. The ease of system expansion.
5. The expected lifetime of the system.

Each of these implies requirements to be defined. The number of users that a system is expected to serve effects several system performance factors. If there are only a few users, it should be relatively easy to recognize, consider, and respond to the demands placed upon the system by each one. In a large school, with many users, it is much more difficult to pay attention to the demands of individual users.

The estimate on the number of users also will effect the optimum performance expected of the system. In addition to this, the efficiency of the system is effected by the number of users in many ways, such as when trying to decide how much storage to purchase for the system, or what services to offer within the system.

Dispersion of the users is very important to the design of any computer system. It is essential to know whether the demands of users will include being able to access the computer from one location, from several centrally located points, or from a large number of geographically separated places. The answer to this question relates directly to efficiency considerations as well. The cost of communication links between a main computer and various attached devices often can be very expensive for particular types of equipment. Knowing if the computing activity must be confined to one room, to several adjoining rooms, or should be dispersed throughout the building, or among several buildings is of prime importance.

It is necessary to determine ways in which the computer is envisioned used in the instructional and administrative programs, and the relative priorities of those uses. Common instructional techniques include drill and practice, tutorial, problem solving, games, simulations, and dialogues. Common instructional functions associated with computer use include computer managed instruction (CMI), test construction and grading (CATC), and data analysis. Related administrative uses include applications such as scheduling, payroll, and student record keeping. The result of such study not ony will define the demands which will be placed upon the system, but directly will influence the choice of input and output media, the main computer itself, the programming languages considered, and the rules and scheduling procedures which will be established for permitting users to gain access to the system. Such a study also will focus on whether a single machine adequately will serve the needs of both administrative and instructional users.

The possibility of system expansion should always be kept in mind, since no matter how large a system is at first, someone later will need more of something. Demands will change and good system response will become important. Hence, compatibility with existing equipment and ease of expanding capabilities should continually be kept in mind. As one example, classroom instruction often can be aided by a TV monitor connected to a computer terminal. This permits more students to see what is going on by looking at the TV screen. This connection can be easily accomplished using CRT terminals, but is almost impossible using typewriter-type terminals.

Related to system expansion is the possible sources of new funds for use with the system. Examples of this might include the selling of time and space to outside agencies or businesses during idle periods. In the school, this might include demonstrating the feasibility of using the computer to help improve the reading skills of special education students qualified for more state or federal aid. Departments within the school may have special interests which could lead them to expand the resources of a basic system for their own use. For example, the guidance department may want to acquire its own terminal for use with a special program to give information on colleges, careers, and job opportunities.

Throughout the entire decision-making process, the expected lifetime of the system should be kept in mind, as well as the nature of the system itself. The requirements and demands placed upon a system that is to be a short-lived, exploratory probe into the feasibility of acquiring a large-scale system later will be considerably different from those of a medium-sized system that is expected to provide computer services for several years. This information also will have an effect upon the way in which the computer services are acquired.

How appropriate is the system?

The appropriateness of a computer system centers around the following issues:

1. The goals of the computer system.
2. Which computer system to acquire?
3. Which computer languages to use?
4. Which vendor(s) to deal with?

Before any procurement decisions are made, the goals of the computer system should be stated clearly. An ordering of the goals by priorities makes decisions easier to justify, and establishes a basis upon which to measure the effectiveness of the system. Once the goals of the system have been established, the question of which computer system to get can be addressed. There are essentially three kinds of computer systems available:

1. Batch processing systems
2. Interactive, multi-user systems
3. Interactive, single-user systems

Generally speaking, for most educational purposes, an interactive system is preferred over a batch processing system since it permits a greater degree of contact between the user and the machine, and makes a greater number of possibilities for creativity and machine use in schooling processes. Interactive systems usually are more expensive, however, and cannot serve the volume of users of a batch system. Computer systems do exist which offer both capabilities, and are probably the best ones for a school to consider, since the advantages of both kinds of systems can be incorporated.

Single user (or single use) computer systems are growing in popularity in the schools. Soon it may be the case that a school will want several small, inexpensive, and dedicated microcomputers in various departments throughout the school designed to be used for the individual needs of those departments.

There are other considerations when choosing a computer system including how the following measures of system effectiveness are to be defined. The measures are:

1. Throughput
2. Turnaround time
3. Response time

Throughput refers to the number of people that can be served by the system in a given time interval; the more people that can be served, the greater the throughput. It is desirable to have throughput as high as possible in any educational system since throughput serves as a measure of system productivity and reduces the per unit costs.

Turnaround time refers to the length of time it takes to receive results after submitting a request. This term usually is associated with batch processing systems. From the users' point of view, it is good to have a short turnaround time--usually less than a second in a timesharing system, a few minutes for batch processing systems. Sometimes, in an attempt to get a high throughput rate in a system, the turnaround time of some complex requests must be increased. Balances and tradeoffs between these two factors often are a prime concern in system design. The idea is for everyone to receive short turnaround with as high a system throughput as possible.

Response time is the time it takes a machine to respond to a direct user request. Usually it is disasterous if a student does not receive virtually immediate feedback to drill and practice, demonstration, or simulation materials since a chain of thought easily is interrupted and broken. However, if the prime goal of a system is to produce students capable of doing computer programming, it may be that slower response time and batch operations are an acceptable approach to take.

Computer languages come in a wide variety of types. For administrative uses, the choice of language will depend upon the equipment chosen and upon the availability of specialized programs to do administrative tasks. When trying to decide on appropriate languages to use in an instructional environment, the three most important factors are the instructional strategies to be used, the subject matter to be taught, and the ability levels of the users. Other factors include the equipment needed to implement the language, the adequacy of record-keeping capabilities of the language, and the experiences of others who have used the same language. Languages suitable for the design of tutorial lessons are not always good for producing simulations, nor is a language

designed for business applications suited to serve as a lesson-writing medium. A language that is easy enough for elementary school students may frustrate more advanced high school students.

How effecient is the system?

The costs which enter into efficiency considerations of the system are:

1. Computer equipment
2. Resource personnel
3. Maintenance
4. Conversion
5. Installation
6. Documentation

Much of the cost of a computer system is that of the computer equipment and peripheral devices. Typically, these can include items such as the following:

1. Computer mainframe
2. Main memory
3. Card reader
4. Line printer
5. Disk drives
6. Magnetic tapes
7. Plotters
8. Air conditioning units
9. Terminals
10. Phones
11. Modems and couplers
12. Cables and connectors
13. Paper tape reader/punch

14. Keypunches

15. Power supplies

For the most part, once the requirements of the system are decided upon, vendors can be contacted, compatibility with existing equipment can be determined, and the specific options desired can be discussed.

Computer equipment may be procured in one of three ways: purchase, lease, or rental. Some of the equipment can be purchased either fully assembled, tested, and guaranteed, or in kit form (especially microcomputers). If facilities and expertise exist within a school for building computer equipment, savings can be realized. Studies have shown that of the three methods for procuring equipment listed above, purchasing is the best, followed by leasing, and then rental. These findings are based upon lowest cost considerations and take into account the effects of leverage which can be exerted upon vendors by withholding payment in order to receive service or support.

The need for and existence of resource personnel must be considered early. It is necessary to determine the preparedness of staff members in programming, maintaining, or using a computer as a resource, as well as in training others to use that resource If no training source is found in the school, the question of whether such people can be hired, what the costs of such training will be, and how long it will take to train staff in these uses must be considered. Also, release time that teachers will need in order to become trained should be entered into cost considerations.

Once it is decided to acquire a system, a very important and often overlooked point is one of maintenance. Too frequently, expenditures are made on equipment and no provision is made to guarantee its continued operation and repair. For computers, maintenance costs can be considerable, running to as much as 2% of the purchase price per month.

Where a computer system already exists, converting to a new system can incur several additional costs. These include the cost of disposing of the current system, re-educating users with the operation of the new system and converting existing programs and files to work on the new system.

Installation costs, including transportation, site preparation and space acquisition, are important to consider before equipment actually is purchased. An analysis of office space, power requirements, and air conditioning costs is essential before system installation is possible. It also is important to find out exactly how long it will take to receive equipment once

it has been ordered. This is called "lead time". It is not uncommon for computer equipment to require several months to be delivered and installed.

The cost of documentation, including programming and user manuals, as well as guides to the overall system software and hardware should not be neglected. Ongoing documentation costs also occur as new or revised programs or lessons become available for use on the system. Such programs should be accompanied by documented materials, and the formation, storage, and dispersal of such materials may increase the cost of the system.

Finally, do not overlook the cost of supplies. Printers and printing terminals require paper. Card readers require cards. Specially designed cards (useful for mark sensed applications) require a set-up fee the first time you order them. This covers the printer's cost of making the printing plates to be used in printing the cards. If you can use a "standard" form card supplied by a vendor, you can save this fee, which may be several hundred to a thousand dollars. Mark sensed cards may require TWO printing plates. The second plate is for the timing marks along the bottom of the card. Thus, there may be two set-up fees.

Who sells the equipment that I need?

Once you have a good idea of what you want a system to do, it is time to send out a "Request for Proposals" (RFP). This is the document which communicates your needs and goals to potential suppliers. The degree to which you have answered the questions previously presented will determine the success of your venture, and your satisfication with the resulting hardware and software.

There are comparative sources available to aid in the process of choosing specific vendors or computer systems. Computers and Automation magazine annually publishes A Computer Directory and Buyer's Guide. It contains lists of computer products for sale or rent along with a description of their characteristics. This source also is good for finding installations with similar interests since it provides a listing of computer centers and the machines they use. Datamation magazine frequently publishes comparisons of vendor offerings in a specific area such as terminals. These comparisons may include several pages of tabled information making comparisons among vendors easy. Discussions with people who already are using equipment in question, or who have investigated the possiblity of using similar computer resources, often are an invaluable aid in acquiring information on a particular product.

There are many formats for an RFP. All such forms should include at least the following items or details:

1. The functions expected of the system or software
2. Vendor field support services required
3. The format you wish bids to take
4. Summary pages for the vendor to supply data in a convenient form
5. Your evaluation techniques and standards for the hardware and software
6. Terms and conditions expected
7. Time line expected for contract award
8. Last possible date for rebids
9. Requirements for vendor references to other users
10. Workload tests and demonstrations required (the "benchmark" demands)
11. Details required for assessment of future conversion or expansion

The following will give you some idea of the specific types of data you are attempting to elicit (and organize) in order to make a decision. Not all items would apply to each procurement task but are included to encourage broad thinking on these matters.

Cost Data

1. Total cost
2. Separate component costs
3. Cost estimates for performance of benchmark jobs
4. Maintenance costs
5. Software costs
6. Personnel training costs
7. Miscellaneous costs

Performance Data

1. Compilation times by compiler or benchmark tests
2. Linkload or collector times on benchmark tests
3. Execution times on benchmark tests
4. Initiation time for operating system
5. Sorting times
6. Legibility of printed output
7. Mean time between failures (MTBF) of various system components
8. Average number of machine instructions needed per line of code
9. Response latency relative to system load
10. Percent of CPU used during benchmark tests
11. Operating conveniences
12. Compatability of existing software
13. Average number of job control parameters required

Hardware Characteristics

1. Full memory cycle time
2. Average machine instruction time
3. Channel number and speed
4. Total memory
5. Total storage
6. Average access time to on-line storage
7. Average access rate to operating system modules
8. Total memory available to single user
9. Floating point and decimal arithmetic capabilities
10. Character coding scheme

11. Word size
12. Availability of clocks (for real time and time of day)
13. Memory expandability
14. Total power requirements
15. Environmental control requirements
16. Physical space requirements for devices

Software Support

1. Language available and features
2. Maintenance and implementation support and costs
3. Utility software available
4. Memory requirements for operating system
5. Machine use accounting software available
6. Inter-language communication
7. Debugging aids
8. Difficulty of generating operating system

Other data

1. Delivery time
2. Proximity of like systems for emergency support
3. Reputation of vendor
4. Availability of personnel trained on hardware or software
5. Vendor training programs
6. Cost and quality of vendor documentation
7. Compatibility to equipment from other vendors
8. Availability of software other than from vendor
9. Purchase options, lease options, guaranteed pricing and duration
10. System features unique to vendor

These lists are not exhaustive but are intended to provide an awareness of the requirements for planning, evaluating, financing, implementing, and administering a computing system.

It is important to determine the amount of supporting services, in terms of maintenance, repair, and consultation which will be offered, as well as the documentation provided with their product. An appropriate checklist of questions to ask a vendor might include the following items:

1. Are there general purpose programs to perform system functions (like an editor or sort program)?
2. What are the characteristics of the operating system?
3. Are there programs and/or manuals that teach programming and equipment operations?
4. Are there programs that aid in developing CAI materials?
5. Are there programs that perform administrative tasks (e.g., payroll, scheduling, or calculating grade point averages)?
6. Does the particular machine have a user group in your area?
7. Are there provisions for consultation on technical problems?
8. Is training on the operation of the machine provided?
9. Do newsletters for equipment exist?
10. Are there libraries of programs that already exist for the machine? If so, how good are they and how much do they cost?
11. What, if any, privacy and security provisions are implemented in the system?
12. Is there some means of communication among users of the system?
13. Is there some method for transfer of information to or from other, possibly unrelated, systems?
14. Is the machine an experimental or new model (and hence almost guaranteed to have problems and unexpected annoyances)?

Some of these questions have implications which might be hidden at first glance. For example, the presence of a large library of programs may not be useful if the programs do not do exactly what one wishes. Hence, the ease with which programs can be modified to meet the needs of the particular application also is important.

Newness of a machine or model is no reason to reject it automatically. It may well be that the new machine is precisely what is needed. However, in such a case, it is important to realize the need for a well-qualified and experienced staff to oversee system operation and to be available to correct problems when they occur. It is not easy to be a pioneer but sometimes the equipment can be purchased more cheaply this way, in the guise of being an experimental system.

Of course, testing the validity of the answers received to the above questions is not an easy task. In fact, there is no sure way of determining whether all the answers given are indeed correct. Frequently, however, talking with users of similar systems, or discussions at user group meetings, can be helpful in determining which claims are valid. Also, an examination of buyers' guides discussed above can help substantiate vendor claims. If possible, an examination should be made of printed materials for clarity, readability, and completeness before they are purchased. Also, serious attempts should be made to view all equipment and software in operation under conditions like those expected.

Should you do your own maintenance or contract with some vendor?

Unless an institution has some very qualified electronics technicians, such as might be found teaching electronic repair in a junior college, doing your own maintenance is not advised. There is a great deal of experience required, not to mention the need for electronic test equipment that most schools do not have.

Should a maintenance contract be with the mainframe vendor or some outside service?

The answer to this question depends upon several factors. One consideration is the availability of vendor service in your area. Some vendors do not have service organizations, hence if you own their equipment, you must use a service organization. You may be physically located so far from the nearest service office that you are outside their service area. Usually if vendor service is available, it is better than a service organization. The service organization's personnel must understand many vendor's equipment, hence, they may not understand any of them as thoroughly as the vendor's own service people. This is the

tradeoff between being mediocre at many things or being very competent at one thing. Vendor service people are very competent at servicing only their employer's equipment.

Should the service contract call for twenty-four hour service or "prime time" only?

"Prime time" is considered to be from 8:00 AM until 5:00 PM weekdays. This is when most people are at work and is the worst time for a computer to be malfuntioning. Prime time contracts are less expensive than 24 hour contracts because the service person is only on call a limited period. Twenty-four hour service requires the service organization to have more manpower to anticipate nighttime failures. Unless your application is very critical, you may not need 24 hour service.

Should the service contract call for billing of a flat monthly rate or should the billing be on a "per call" basis?

If the contract calls for a monthly fee, that is what is paid regardless of the number of service calls in a month. With a "per call" contract, you are billed only for the service calls made during the month--the more calls, the more you pay. If you are just starting with a new system, a flat rate contract is probably the best (at least for the first year). Once you have experience with the machine and know how many failures to expect per month, you might consider switching. The per call contract is usually cheaper, particularly if the machine is reliable.

What is the response time to a service call?

A vendor may give you a great deal on a service contract but his nearest office is 600 miles away. The technician must take an airplane to reach your city (or drive). If you can find someone with a local office, or at least closer to your city, choose them. (unless, of course, the long delay for service is not important.)

Once you have a service contract, you can help the technician locate a problem if you can give him more information than "It does't work". You might even be able to save a service call. Suppose your terminal quits working. First check to see that it is plugged in. There are an amazing number of service calls resulting from unplugged equipment. Next, make sure the wire connecting the terminal to the modem or computer is still plugged in. These simple checks could save you several service calls a year.

It is also useful to be able to differentiate between hardware problems and software problems. You do not want to call your hardware service representative only to find out that the problem was software. If you are at a terminal and the computer seems to be malfunctioning, check to see if other terminals are having problems. If they are, and they are using different programs, then the problem is most likely a hardware one. If, however, all the terminals having problems are using the same program, then the program is most likely at fault. To verify this, run a different program on one of the failing terminals (if possible). If the problem disappears, then it is definitely the program that is failing not the hardware.

Once you have decided that hardware is the problem, you need to isolate the component that has failed. There may be a different service organization for different parts of the system, and you need to know which one to call. To illustrate, consider a system with several terminals scattered around and connected by telephone. A problem is occurring at a terminal. The problem might be with the terminal itself, the terminal's modem, the phone lines, the computer's modem, or the computer itself. If the computer is at fault, it usually is obvious since nothing works correctly. However, if the error is in one of the other components, the failing component is harder to determine. Some modems have a diagnostic display (usually in the form of lights displaying the status of various signals). If modems do not have these displays, you have little choice but to place a service call with one of the service organizations and let them tell you where the problem is (possibly wasting a call if it is someone else's problem). For the modems with diagnostic lights, make sure both the computer and terminal modems have the "carrier detect" light on. If one of the lights is not on, then the other modem is not transmitting the carrier signal and probably is bad. If both modems have carrier detect lights, have someone watch the "transmit data" light on the terminal's modem and the "receive data" light on the computer's modem. Then press a key on the terminal. If the transmit data light does not flash, the problem is either the terminal, the connection from the terminal to its modem or that modem. If it does flash and the receive data light at the computer does not, then the problem is in the phone line, or the computer's modem. If the phone line is bad, the carrier detect signals usually will be absent on both modems.

This sort of procedure (isolating the failing component) can be used for other devices on a system. Unfortunately, most other devices do not have the nice diagnostic lights like modems do. Usually, peripheral devices come with some sort of "diagnostic program". These programs exercise all of the functions of the device in question and give some sort of message if the device fails a test.

Procuring software

Planning for procurement of much software is included in the planning for the hardware. Software often comes with the machine. When the time comes that you need programs not available on your system, the same careful analysis of what is needed is necessary as when procuring hardware. Once you have determined what the new software should do, there are two major methods of obtaining it. You may either write the software yourself, or buy the software from a software vendor. If you elect to write the software in-house, who is going to write it? If there are teachers or professional staff who are experienced programmers, they might be the logical choice to do the work. This is probably the most expensive method, unless the person agrees to do the work on his own time for free. Otherwise, you need to consider the cost of the person's salary (or fraction thereof) as the cost of the software.

There is an often overlooked source of inexpensive programming manpower available in schools, the students. If you are not in a big hurry for the software, student programmers can do the work. They may not work as rapidly as more experienced programmers, but they often will work for free (or in exchange for the use of the computer for their own amusement).

Finally, if you are lucky, one of the computer magazines may publish a program in one of their issues that is very close to what is needed. There are a great many of these magazines and they publish hundreds of programs each year.

If experience is not available in-house to write the needed software, then you must purchase or lease the software. Once you have determined exactly what the software should do, and have selected several likely offerings from vendors, ask the following questions:

1. How well does the package fit the job and the users?

2. How easy is the package to modify?

3. How much does the package cost?

It is unusual that one package does exactly what is desired. The software you select should be easy or inexpensive to modify to suit the needs of the institution. If the vendor does not supply source code, modffications may be impossible except for payment of a fee. Details of such conditions need to be revealed before purchases are finalized.

About the only sure way to evaluate software completely is to experience it in operation. This means a visit to a site where the programs operate and a reasonable amount of time personally executing tasks on the system. For administrative software, it is not unwise to include clerical users in such visits to see how they react to the services provided by the software.

STUDY ACTIVITIES

1) Your school has decided that they need a hardcopy printer for their computer system. The desired characteristics of this printer are:

1. It must print at least 80 columns wide and accept paper that is at least 9-1/2 inches wide.

2. It must be capable of both pin (tractor) feeding and friction feeding forms, and easily interchangable between the two.

3. It must produce at least an original and 3 legible carbon copies.

4. It must be able to print on school letterhead (for printing form letters).

Prepare a request for proposals for this printer. To do so, invent a typical printing task to use as a "benchmark" and to determine the capacity of the device.

2) Survey the available vendor literature as well as back issues of the various computer magazines and try to determine which vendors have products which fit the above specifications.

3) Your school has decided to purchase a program to compute the best school bus routes. What input would be necessary for the program? Decide what criteria the program should meet in order to be worthwhile to purchase.

4) The school board would like to write payroll checks using a computer. You already have a hardcopy printer capable of handling checks but the only storage medium available is cassette tape. Decide what, if any, new hardware is required for this application. Explain why. (Note: No new hardware must be required. See back issues of Kilobaud magazine for a payroll program using cassette tape.)

Operation and Management of School Computers

Once a computer system is purchased, whether small or large, it becomes another resource of the school. As such, it requires some management. Management of an educational computer facility can be divided into three areas. The first is general upkeep: the continuing jobs of providing sign-ons, storage, backup storage, and computer time for everyone, maintenance of the computer, and making programs available to people who need them when they need them. The second aspect is collecting and maintaining good information about the programs available on the system. The third is providing for easy operation and use of the computer. People should not need to be computer experts to be able to use computers and indeed there are few computer experts working in schools.

Throughout this section, the assumption is made that there is a director or manager (possibly you) in charge of these tasks and making the facility accessible to users in the school. This person should have some computer background (programming and computer use) and should be familiar with the computer being used. It is important that the person obtain any manuals regarding the computer, read them thoroughly, and keep them on hand. The person should know what can and cannot be done on the system or be able to find out quickly. Also, they should have a fairly thorough knowledge of programs available on the system pertaining to different tasks and should be accessible as a consultant to users.

General upkeep

General upkeep involves the day-to-day scheduling and maintenance of the computer facility. Non-computer tasks include scheduling user time on the computer, maintenance of the actual computer hardware, and keeping computer information up to date and available. Computer work includes distribution of actual computer time to those who need it (computers that have accounting systems require certain sign-ons or passwords), allocation of program storage space (disk or tape storage), and maintaining proper program protection, allowing access for those who need it, but, for example, letting programs be changed only by their authors. Allocation of disk space must be done on a priority system if space is limited. Cases will arise where not enough space is available and procedures must be arranged for determining who gets how much. Protection of programs and data files must be established to prevent accidental or illegal changes or deletions of important programs, or access to data files that should be secure.

It is necessary to keep available accurate, up-to-date information about the computer. Information about system software or procedural changes should be well documented, up to date, and available to users.

On systems for which programs are stored on disk, it is worthwhile to have duplicate (backup) copies of everything kept on some storage medium as a precaution against loss of programs due to disk malfunctions. There should always be at least two copies of everything. The backup copy should be stored somewhere off the premises as a means of recovery in case of a natural disaster.

Collection and distribution of program information

If a school wants to get maximum use out of a computer system, people need to know what the computer can do and what programs are available. This is most true for instruction or teacher service type programs. The following paragraphs detail one such method which keeps three kinds of information.

The first kind of information is common to almost all computers in some form. It consists of a directory, automatically created by the computer, of all programs stored in the computer. Some of these programs are of value, while others are just practice programs by people learning to program. These practice programs will be deleted periodically. Information given by the system directory usually is very limited, but this can be supplemented by running a program to find out what it does and how well it does it.

A second way to document what is on the system is to set up a filing cabinet with a library of programs. Enough space in the file cabinet is set aside for one folder for each program worth saving. In this folder is a listing of the program and, as they are accumulated, some sample runs of the program. Also, any data, critiques, suggestions, or reports pertaining to the program can be included in its folder. This will serve as help for those who might want to use or edit a program in the future. The folders should be organized perhaps by program name. This is a system that allows, upon request, quick access to all the information on a specific program. Most of the programs included in this file also should be stored with backup information. This is a protection against any deletions or alterations of the copy on the system.

The third set of information is that used to publicize what programs are available on the system. This consists of some sort of listing of the programs, arranged by subject areas, with a short description of each.

Providing for Easy Computer Operation

Suppose that the computer is available and an interesting program has been found by a new user. It is now important for that user to get in and work with the computer as easily as possible. If he has no computer experience, he should not be hindered by that fact. If he has no desire to learn to program or to learn the intricacies of computer hardware or a set of monitor commands (other that the log-in procedure), he still should be able to use the computer.

There are three ways to work on making program usage easy. First, there should be concise, simple to understand instructions posted or in hand-out form that describe the minimum computer knowledge necessary to use the machine: logging in, getting and executing a program, and logging off. There also should be some condensed computer language reference sheets for those who are programming, giving a brief description of each computer language command and its syntax.

The second way to expedite program use is with a program which converses with the user. By the use of a "router" or "menu" program, anyone can get on the computer and use any of the programs after learning to log on and run one program. This facilitates easy terminal sessions for beginners, unclogged by computer jargon. A router program should give the user a short description of each progam, with the option to choose one (preferably by a number) to run. Other choices available might be to leave a message on the computer for the manager, or to leave the router. A router should load all data files needed by a chosen program and then transfer to the chosen program (in BASIC, this is called the CHAIN command). When the program finishes, control should return to the router.

The third way to expedite program use is in the design of the programs themselves. Each program should be documented well for the user and for the computer manager. Comments should identify the program and the author to anyone reading the listing. Variable and subroutine definitions should be included in the folder for that program.

Another type of documentation helps to insure that the user will understand the program. The program should print enough information so that the user knows exactly what he is doing and what input is required of him at any given time. Instructions to the user should be clear from the beginning of the program and the flow of the program should be easy to understand. Furthermore, each program should have a quality that very few programs actually have: they should be user-proof. When the user enters a response, it should be checked to see that it is an acceptable one. For

example, if the program asks for a yes/no answer, the program should not assume that if the answer is not "yes" then it is "no". An accidental press of the RETURN key could break the flow of the program. (It is also convenient if the program accepts "y" for yes and "n" for no). A general rule of thumb is that there should be no way the user can accidentally exit from the program. Typing errors by the user should be caught and questioned, and means should be available for correction if an irreversible wrong choice is made (e.g., accidentally choosing to delete important data).

Summary of System Management

The following summary includes the major tasks in providing good service with an educational computer.

1. General Upkeep
    1. Scheduling of computer terminal time
    2. Providing computer maintenance
    3. Allocation of computer time
    4. Keeping backup copies of programs
    5. Allocation of computer storage space (disk)
    6. Providing proper protection of programs
    7. Making programs available when needed
2. Information on Programs
    1. Listings of system directories
    2. "Library" files (folders) about each program
    3. Lists of available programs and descriptions to be distributed
3. Easy Operation of the Computer
    1. Simple, concise beginner's instructions
    2. Reference handouts for computer commands
    3. Computer routing to facilitate sessions at the terminal
    4. Programs well documented for possible alterations in the future

5. Programs easy to understand and use

6. Programs user proof

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